Bonneville Power Administration
Fish and Wildlife Program FY98 Watershed Proposal Form

Section 1. General administrative information

Title **Evaluate responses of Snake Basin watersheds and salmonid habitats to recent storms.**

Bonneville project number, if an ongoing project 9703500

Business name of agency, institution or organization requesting funding

Columbia River Inter-Tribal Fish Commission

Business acronym (if appropriate) CRITFC

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
Clearwater Biostudies, Inc.	23252 Central Point Rd.	Canby, OR 97013	Chuck Huntington
F. Al Espinosa, Jr., Consulting Fish. Biologist	735 Vista	Moscow, ID 83843	F. Al Espinosa, Jr.
Dr. C. Frissell, Restoration Ecologist/Research Assistant Professor	Univ. of Montana, Flathead Lake Biol. Station, 311 Bio Station Ln	Polson, MT 59860-9659	Dr. C. Frissell

NPPC Program Measure Number(s) which this project addresses.
3.3D.1, 7.6B.4, 7.6C, 7.6C.2, 7.6C.5, 7.6D

NMFS Biological Opinion Number(s) which this project addresses.

The NMFS ESA Section 7 - Consultation Biological Opinion Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests (NMFS, 1995) established a Riparian Management Objective (RMO) of <20% surface fines in spawning habitat in "high priority watersheds," such as the watersheds of the Salmon River. NMFS (1995) also called for development of baseline information, monitoring land management effects and progress towards meeting objectives (p. 68), and periodic measurement of important habitat components as part of effectiveness monitoring (p. 86). The project will address all of these recommendations by substrate and channel conditions watersheds in the Salmon River Subbasin, and, potentially, the Tucannon River Subbasin.

Other planning document references.

Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon, The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes (CRITFC, 1995) sets a substrate standard of <20% surface fines in spawning habitat and <30% cobble embeddedness in rearing habitat. CRITFC (1995) also calls for monitoring of trends in fine sediment levels and pools in rearing and spawning natal habitat to ascertain progress towards habitat recovery (pp. 5B-10, 5B-38).

The Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (USFS and USBLM 1995) established RMOs for pool frequency and large woody debris in anadromous fish habitat. These habitat attributes will be monitored in reaches selected for study.

Subbasin.

Clearwater River, Salmon River, Tucannon or Grande Ronde River

Short description.

Inventory and analyze mass erosion and change in habitat conditions in response to storms in watersheds with different levels of land disturbance. Investigate relationship of watershed and habitat response to land use. Prioritize protection and restoration measures based on results.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction	X	Watershed
*	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production		Population dynamics
	Oceans/estuaries		Research	*	Ecosystems

_____	Climate	X	Monitoring/eval.	_____	Flow/survival
_____	Other	*	Resource mgmt	_____	Fish disease
		_____	Planning/admin.	_____	Supplementation
		_____	Enforcement	_____	Wildlife habitat en-
		_____	Acquisitions		hancement/restoration

Other keywords.

cumulative effects, sediment delivery, flood effects

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
		No other projects are directly dependent on the funding of this project.

Section 4. Objectives, tasks and schedules

Obj 1,2,3	Objective	Task a,b,c	Task
1	Select basins, watersheds, and salmonid habitats for investigation and characterization of response to storms/floods	a	Review available information on storms, hydrologic response, mass failures, channel response, pre-storm habitat data, watershed characteristics (e.g., geology, vegetation, topographic relief, etc.) in candidate basins and watersheds; select watersheds and salmonid habitats for intensive study based on study criteria. Note: will be completed with FY 97 funds.

2	Characterize and investigate watershed response to storms/floods, including mass failures and potential relationship to potentially controlling variables (e.g., slope, geology, elevation, land use, etc.)	a	In watersheds selected for intensive study, obtain and analyze pre-storm airphotos, post-storm airphotos (if available), available GIS layers, aerial inventory data on mass failures, existing data sets on mass failures and potentially controlling variables, interview resource specialists to augment analysis of existing data, and identify data gaps in the existing information related to watershed response, mass failures, and potentially controlling variables. Note: Will be completed with FY 97 funds.
		b	Aerial inventory of mass failures, as needed to fill data gaps identified in Task a of Obj. 2. Note: Will be completed with FY 97 funds.
		c	On-the-ground inventory of mass failures and potentially controlling variables, as needed to ground-truth existing data sets and fill identified data gaps. Note: Will be partially completed with FY 97 funds.
		d	Obtain streamflow gage and precipitation records to determine return intervals for storms and flows via standard hydrologic analysis. Note: will be completed with FY 97 funds.
3	Evaluate habitat response to storm/flood events and assess ramifications to egg-smolt survival.	a	In watersheds selected for intensive study, obtain and analyze existing pre- and post-storm data on habitat conditions in reaches selected for intensive study and identify data gaps in post-storm data on habitat conditions. Note: Will be completed with FY 97 funds.

		b	Inventory key habitat conditions in habitat reaches selected for intensive study, as needed to ground-truth habitat condition data sets and fill identified data gaps in habitats in watersheds selected for study. Note: Will be completed with FY 97 funds.
		c	Determine magnitude and statistical significance of changes in habitat conditions from comparisons of pre- and post-storm habitat data in reaches selected for intensive study.
4	Investigate differences in watershed and habitat response in relation to watershed condition and land use	a	Analyze and summarize data on mass failure frequency and volume by watershed.
		b	Investigate potential relationship between results in Task C of Obj. 3 and Task A of Obj. 4.
5	Investigate potential relationship of potentially controlling variables with mass failure volume and frequency	a	Determine age and type of disturbance where associated with mass failures.
		b	Analyze potential relationship of mass failure data to potentially controlling variables, such as, land use, land type, disturbance age, slope, elevation, geology, aspect, etc.
6	Identify priority measures to restore and protect salmon habitat conditions from degradation.	a	Synthesize and summarize findings in draft report distributed for peer-review.
		b	Address peer review comments in final report distributed to fish management/land management agencies with results presented to regional groups, model watershed groups, and watershed councils. Submit article on results to peer-reviewed journal for publication.

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	1/1998	3/1998	Not applicable. Will be completed with FY 97 funds.
2	3/1998	10/1998	5% of FY 98 funds. The rest of this objective will be completed using FY 97 funds.
3	3/1998	12/1998	10% of FY 98 funds. The rest of this objective will be completed using FY 97 funds.
4	5/1998	2/1999	35% of FY 98 funds. The rest of this objective will be completed using FY 97 funds.
5	5/1998	2/1999	30% of FY 98 funds. The rest of this objective will be initiated using FY 97 funds.
6	12/1998	6/1999	20% of FY 98 funds.

Schedule constraints.

High streamflows or severe weather may delay or truncate field work.

Completion date.

If funded with FY 1998 funds, 1998 will be the last year in which funding is needed. If not funded with FY 1998 funds, 1999 will be the last year that funding is expected to be required.

Section 5. Budget

Item	Note	FY98
Personnel	Project leader/hydrologist for 1.6 mo.	$6,280 (if not funded in FY98)
Fringe benefits	31.5% of salaries	$1,978 (if not funded in FY98)
Supplies, materials, non-expendable property		$0.0
Operations & maintenance	Postage and photocopying for 12 mo.	$300
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		$0.0
PIT tags	# of tags:	
Travel	Per diem, lodging, car rental and fuel	$768
Indirect costs	37.9% of personnel, fringe, supplies, and travel	$3,535
Subcontracts	Clearwater BioStudies, Inc.: $18,000; F.A. Espinosa: $4,000; Dr. C. Frissell: $4000	$26,000
Other		$0.0
TOTAL		$38,861

Outyear costs

Outyear costs	FY99	FY00	FY01	FY02
Total budget	$0.0	$0.0	$0.0	$0.0
O&M as % of total	0	0	0	0

Section 6. Abstract

The storm/flood events of 1995-1996 provide a critical opportunity to evaluate the response of salmon habitats in watersheds with differing levels, types, and patterns of land-

use (Reid and Dunne, 1997). Our investigation of response to storm/ flood events will examine reaches and watersheds with differing levels or patterns of land-use, with areas of study selected for based on a hierarchical classification of stream and watershed characteristics so that study areas are comparable except for patterns of land-use. Mass failures volume and frequency will be inventoried and the relationship with potentially controlling variables, such as slope, geology, and land-use will be investigated. Habitat conditions in stratified reaches will be monitored and change determined via comparison with pre-storm data. Results will be used to: 1) identify watershed and habitat restoration and protection priorities at the subbasin scale; 2) update information on habitat conditions; and, 3) determine progress towards attaining regional habitat objectives.

Section 7. Project description

a. Technical and/or scientific background.

Widespread habitat degradation has contributed to the on-going decline of spring chinook in the interior Columbia Basin (e.g, Henjum et al., 1994; USFS and USBLM, 1997). Currently, several regional salmon restoration plans seek to increase egg-to-smolt salmon survival by improving degraded habitat conditions (NPPC, 1994; CRITFC, 1995) or, at a minimum, avoid increased degradation (NMFS, 1995). However, watershed restoration and habitat efforts may be ineffective if they do not target watershed impacts that cause severe and long-lasting habitat degradation during storms and floods or if short-term improvements are reversed due to the effects of land management triggered by storm events. Effects triggered by recent floods may have degraded habitat and reduced salmon survival in some drainages. Data from the South Fork Salmon River in Idaho, indicate that landsliding from logging and roads in the mid-1960s reduced salmon survival from egg-to-smolt over a period of more than 30 years (Megahan et al., 1992). Identification of the most pressing restoration and protection needs provides a means to avoid habitat degradation and long-term reductions in salmon survival triggered by future storm events.

The storm and flood events occurring in the Snake River Basin from 1995 to 1996 provide a rare and critical opportunity to: 1) investigate the frequency and volume of mass failures caused by infrequent, large magnitude precipitation and flow events (Reid and Dunne, 1997) and 2) determine if salmon habitat conditions are improving as is the goal of several salmon recovery plans (e.g., CRITFC, 1995; NPPC, 1996). These goals may not be realized because salmon habitat is affected by the cumulative effects of watershed conditions that can cause relatively rapid changes in habitat conditions during large precipitation/flow events (Reid and Dunne, 1997). This study will evaluate and compare the response of managed watersheds and their embedded salmon habitats to the recent storm/flood events with the response of watersheds and salmon habitats with little or no history of anthropogenic disturbance. Such an evaluation is critical because the full, long-term consequences of land management on habitat condition and resultant egg-to-smolt salmon survival are often not completely expressed until triggered by storms and floods (Reid and Dunne, 1997).

The project will compare watershed and habitat response in at least two subbasins in the Snake River basin. Subbasins will be selected based on availability pre-storm data and their inclusion of multiple watersheds that have different levels of land-use, but that are otherwise broadly comparable based on hierarchical classification (Frissell et al., 1986). In each selected subbasin, at least two (and preferably more) watersheds with differing levels of land use within subbasins will be selected for intensive study based on their comparability using hierarchical classification of natural attributes, including geology, drainage area, vegetation, and elevation (Frissell et al., 1986). Additional criteria for subbasin selection are that the subbasins have reaches that: a) are broadly comparable based on hierarchical classification (Frissell et al., 1986), within watersheds with different patterns and types of land-use; b) contain anadromous fish habitat; and, c) are sensitive to cumulative effects due to environmental attributes and their position within watersheds (Reid and Dunne, 1997). Preliminary assessment indicates that the Clearwater River and Salmon River subbasins contain watersheds that meet the selection criteria.

In the selected watersheds, mass failures will be investigated because previous investigations indicate that mass failures dominate the sediment budget in much of the Snake River basin underlain by the Idaho batholith (Megahan et al., 1978). The condition of environmental variables associated with mass failures will also be monitored and investigated in an effort to identify and prioritize restoration and protection measures to reduce and prevent sediment delivery during storm events.

In stream reaches selected for study within watersheds, pools, substrate, channel stability, and large woody debris (LWD) conditions will be monitored, depending on the availability of pre-storm data on these variables. It is anticipated that the primary monitoring focus will be on pool and substrate conditions for the following reasons. First, fine sediment and sedimentation, including pool loss appear to be a major problem in salmon habitats in much of the Snake River basin (IDHW, 1989; CNF, 1991; Rhodes et al., 1994; Huntington, 1995; McIntosh, 1995). For instance, in a large scale study on the Clearwater National Forest, Huntington (1995) found that fine sediment levels in salmonid habitats within stratified reaches were lower in unroaded watersheds than in roaded watersheds. These differences were statistically significant and greatest in low gradient streams that are typically the most productive salmon habitats (Huntington, 1995).

Second, these habitat attributes are the most likely to be affected by the effects of large storms (Lisle, 1982; Reid and Dunne, 1997). Third, available information indicates that changes in pool volumes and substrate condition affect salmon survival in natal habitat and that trends in these habitat attributes can be used to infer trends in habitat quality related to salmon survival from egg-to-smolt (Peterson et al., 1992; Bauer and Burton, 1993; Rhodes et al., 1994; McIntosh, pp. 6-9, 1995). Fourth, pools and substrate are the habitat attributes most likely to be affected by storms and floods (e.g., Lisle, 1982; Reid and Dunne, 1997). Fifth, these habitat attributes have also been measured in many salmon habitats prior to the recent storms and floods (Platts et al., 1989; Rhodes et al., 1994; McIntosh, 1995; Huntington, 1995; Espinosa et al., 1997), providing pre-storm data

which can be used to determine habitat changes via comparison with post-storm data. Sixth, these habitat attributes have been used to set habitat objectives or standards under several land management or salmon protection and restoration plans, including NPPC (1994), NMFS (1995), CRITFC (1995) and USFS and USBLM (1995); these same approaches also recommend monitoring of trends in these habitat conditions.

Some aspects of the storm/flood events' effects on mass failures and habitat conditions have been previously investigated on the Clearwater National Forest (McClelland et al., *in process*). However, our study differs considerably from the work of McClelland et al (*in process*) in several ways. First, McClelland et al. (*in process*) investigated mass failures rates and volumes and the relationship to potentially controlling variables across the national forest, rather than examining mass failure response within stratified watersheds as a context for analyzing and interpreting changes in habitat conditions within watersheds with different levels or patterns of land use. Second, McClelland et al. (*in process)* did not focus on aggregate watershed response in specific watersheds with differing levels of disturbance. Third, McClelland et al. (*in process*) did not use hierarchical classification to select reaches within watersheds with differing levels of disturbance for determination of post-event changes in habitat conditions in watersheds with differing levels of land use. Instead, the study design of McClelland et al., focussed on habitat conditions in areas immediately up and downstream of landslide sites. Fourth, McClelland et al. (*in process*) looked only at mass failures and habitat change in the Clearwater River Subbasin, lumped across several strata of watersheds and strata of stream reaches. In contrast, our study will focus on watershed and habitat response in specific watersheds and habitats with differing levels of land use, selected via hierarchical classification, in at least two subbasins, allowing a more focussed context for investigating the relationship of watershed response to habitat response, and determining differences in habitat response in watersheds with different land use.

Additionally, in McClelland et al. (*in process)*, much of the information on mass failure volume and frequency and controlling variables were estimated from secondary sources such as maps and aerial photos. While our project will also rely on such methods, it will be cross-checked with measurements of actual field conditions. However, to the extent possible, our project will review and use available data and information salient to our study, including that in McClelland et al. (*in process*) to complement our sampling and analysis and make it more efficient.

The proposed project will also provide an updated assessment of the current condition of key aspects of salmon habitat that can focus efforts to save weak salmon stocks from extirpation. The results will also aid in establishing regional and sub-regional watershed restoration priorities by providing an investigation of which land management activities resulted in the greatest damage to salmon habitat, similar to recommendations in Reid and Dunne (1997). In aggregate, the study will supply information to: determine trends in habitat conditions, the consistency of those trends with the objectives of salmon restoration/protection approaches (NPPC, 1994; CRITFC, 1995), identify degraded habitat attributes in specific watersheds requiring recovery, and prioritize regional and

sub-regional watershed restoration measures needed to improve egg-to-smolt survival for those badly depressed and declining spring and summer chinook stocks in the upper Snake River Basin.

b. Proposal objectives.

Objective 1: Use hierarchical classification (Frissell et al., 1986) to select basins, watersheds, and habitats for investigation and characterization of response to storms based on review of available information on environmental, land use, and biologic attributes and availability of pre-storm data.

Objective 2: Characterize watershed response to storm and floods including mass failures and inventory of potential controlling variables (e.g., slope, geology, elevation, land use, etc).

Objective 3: Evaluate salmon habitat response to major storm and flood events and assess general effects on egg-to-smolt salmonid survival.

Objective 4: Investigate differences in watershed and habitat response in relation to watershed condition and land-use.

Objective 5: Investigate the role of potentially controlling variables, including specific practices, in mass failure volume and frequency.

Objective 6: Identify priority measures to restore and protect salmon survival from egg-to-smolt and report findings to management entities, watershed councils, and in peer-reviewed journal.

The project will also test the following additional hypotheses that have major ramifications for watershed management and efforts to increase the egg-to-smolt survival of salmon: 1) Watersheds with greater magnitude of land disturbance, such as logging and road construction, responded differently to the storm/flood events than watersheds with a lesser magnitude of land disturbance; 2) Salmon habitats in watersheds with a greater magnitude of land disturbance, responded differently to the storm/flood events than those in watersheds with a lesser magnitude of land disturbance; 3) Specific types of land disturbance (e.g. types of roads) responded differently to the storm/flood events; 4) The habitat objectives of the FWP (NPPC, 1994), CRITFC (1995), NMFS (1995), and USFS and USBLM (1995) for channel/habitat conditions are being met or progress is being made toward attaining those measurable objectives.

c. Rationale and significance to Regional Programs.

The proposed project will inventory and analyze updated habitat conditions and trends in conditions, including substrate, pools, and channel morphology in habitat reaches in watersheds with differing levels of land use. This will provide a critical assessment of

differences in trends in watersheds with different levels of land use, since storm/floods have long term effects on salmon habitat. As recommended in NPPC Fish and wildlife measure 7.6C2, the project will supply trend data to determine progress and compliance with NPPC objectives for pool frequency and substrate as set in NPPC Fish and Wildlife Program measure 7.6D. Collection of trend data in key habitat variables such as substrate conditions have repeatedly been recommended in regional efforts to protect/restore salmon habitat (CRITFC, 1995; NMFS, 1995).

The project will also supply data that will provide an indication of habitat trend and status with respect to substrate, pools, and channel morphology within the context of hierarchical classification; this data will be supplied to both Streamnet and CIS, as recommended in NPPC Fish and Wildlife Program measure 3.3D1. The project will also provide updated data on conditions within stream reaches, as recommended in NPPC Fish and Wildlife measure 7.6C. The results of the project will presented to watershed councils, including the Clearwater Subbasin Focus Watershed, and entities interested in improving salmon habitat.

The NMFS ESA Section 7 - Consultation Biological Opinion Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests (NMFS, 1995) established a Riparian Management Objective (RMO) of <20% surface fines in spawning habitat in "high priority watersheds," such as the watersheds of the Salmon River. NMFS (1995b) also called for development of baseline information, monitoring land management effects and progress towards meeting objectives (p. 68), and periodic monitoring of measurement of important habitat components as part of effectiveness monitoring (p. 86). *Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon, The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes* (CRITFC, 1995) sets a substrate standard of <20% surface fines in spawning habitat and <30% cobble embeddedness in rearing habitat. CRITFC (1995) also calls for monitoring of trends in fine sediment levels and pools in rearing and spawning natal habitat to ascertain progress towards recovery (pp. 5B-10, 5B-38).

d. Project history

The previous project number was 55056300 (now 9703500). Due to administrative delays, project funding will begin on Jan. 1, 1998. Therefore, to date, the project has not generated reports, technical papers, or major results.

Adaptive management implications include the following. The proposed project will provide an updated assessment of the current condition of key aspects of salmonid habitat that can focus efforts to save weak salmon stocks from extirpation. The results will also aid in establishing regional and sub-regional watershed restoration priorities by providing an investigation of which land management activities resulted in the greatest

damage to salmon habitat, similar to recommendations in Reid and Dunne (1997). In aggregate, the study will supply information to: determine trends in investigated habitats related to the objectives of NPPC (1994), CRITFC (1995) and USFS and USBLM (1995); target degraded habitat attributes in specific watersheds requiring recovery; and prioritize regional and sub-regional watershed restoration measures needed to improve egg-to-smolt survival for those badly depressed and declining anadromous and resident salmonid stocks in the upper Snake River Basin.

The project will be funded for $115,000 from Jan. 1, 1998 through Dec. 1998.

e. Methods. *Each proposer should complete the methods section with an objective assessment of factors that may limit success of the project and/or critical linkages of the proposal with other work (e.g., a smolt monitoring program, etc.).*

Obj.1, Task a: Based on hierarchical classification (Frissell et al., 1986), select watersheds and habitats for intensive investigation based on available information on storms, hydrologic response, mass failures, land use, channel response, pre-storm habitat data, watershed characteristics (e.g., geology, soils, vegetation, relief, etc.) and habitat/stream attributes (e.g., gradient, salmonid assemblages, etc.) in candidate basins and watersheds.

Obj. 2, Task a: In watersheds selected for intensive study, obtain and analyze pre-storm airphotos, post-storm airphotos (if available), available GIS layers, aerial inventory data on mass failures, existing data sets on mass failures and potentially controlling variables, interview resource specialists to augment analysis of existing data, and identify data gaps in the existing information related to watershed response, mass failures, and potentially controlling variables. Note: Will be completed with FY 97 funds.

Obj. 2, Task b: Aerial inventory of mass failures frequency and location, as needed to fill data gaps identified in Task a of Obj. 2. Note: Will be completed with FY 97 funds.

Obj. 2, Task c: On-the-ground inventory of mass failure volume and potentially controlling variables (e.g. slope, geology, aspect, elevation, etc.), as needed to ground-truth existing data sets and fill identified data gaps. Note: Will be partially completed with FY 97 funds.

Obj. 2, Task d: Obtain streamflow gage and precipitation records and determine return intervals for storms and flows via standard hydrologic analysis (Dunne and Leopold, 1978). Note: will be completed with FY 97 funds.

Obj. 3, Task a: In watersheds selected for intensive study, obtain and analyze existing pre- and post-storm data on habitat conditions (pools, substrate, LWD and channel stability) in reaches selected for intensive study and identify data gaps in post storm data on habitat conditions. Note: Will be completed with FY 97 funds.

Obj. 3, Task b: Inventory key habitat conditions (pools, substrate, LWD, channel stability) in habitat reaches selected for intensive study, as needed to ground-truth habitat condition data sets and fill identified data gaps in habitats in watersheds selected for study. Note: Will be completed with FY 97 funds.

Obj. 3, Task c: Determine magnitude of changes in habitat conditions from comparisons of pre- and post-storm habitat data in reaches selected for intensive study; use nonparametric analyses of variance (for paired and non-paired groups, as appropriate) to test for statistical significance of changes.

Obj. 4, Task a: Analyze and summarize data on mass failure frequency and volume by watershed.

Obj. 4, Task b: Investigate potential relationship between results in Task C of Obj. 3 and Task A of Obj. 4.

Obj. 5, Task a: Determine age and type of disturbance, based on historical records, if available, where associated with mass failures.

Obj. 5, Task b: Analyze potential relationship of mass failure data to potentially controlling variables, such as, land use, land type, disturbance age, slope, elevation, geology, aspect, etc.

Obj. 6, Task a: Synthesize and summarize findings in draft report distributed for peer-review.

Obj. 6, Task a: Address peer review comments in final report distributed to fish management/land management agencies with results presented to regional groups, model watershed groups, and watershed councils. Submit article on results to peer-reviewed journal for publication.

The study will focus on: 1) fine sediment levels and pool volume and frequency in index reaches of salmon habitat within watersheds selected for study; and, 2) the volume and frequency of mass failures within watersheds selected for study and their association with potentially controlling variables such as aspect, elevation, geology, and land use, as recommended by Reid and Dunne (1997). These foci have been chosen for several reasons. First, fine sediments and sedimentation, including pool loss, appear to be the major factor limiting salmon survival in natal salmon habitats in the Snake River basin (IDHW, 1989; Rhodes et al., 1994; Huntington, 1995; McIntosh, 1995). Second, available information more than amply indicates that increases in fine sediment and decreases in pool volume synergistically tend to reduce salmon survival from egg-smolt (e.g, Peterson et al., 1992; Bauer and Burton, 1993; Rhodes et al., 1994; McIntosh, pp. 6-9, 1995), thus, a detectable shift in these habitat attributes is adequate indicator of whether salmon habitat conditions have improved or deteriorated. Third, these habitat attributes are also the most likely to be affected by the effects of large storms with relatively long recurrence intervals (Lisle, 1982; Reid and Dunne, 1997). Fourth, these attributes have

been measured in many salmon habitats, prior to the recent storms and floods (Platts et al., 1989; Rhodes et al., 1994; McIntosh, 1995, Espinosa et al., 1997), providing a database which can be used to determine changes from pre-storm habitat conditions.

Previous investigations indicate that throughout much of the Snake River basin, underlain by the Idaho batholith, mass failures dominate the sediment budget in both roaded (Megahan et al., 1978) and unroaded watersheds (USFS, 1981). Reid and Dunne (1997) note that where previous investigations have already identified the dominant source of sediment in sediment budgets, other sources can be reasonably ignored in estimating contributions of sediment from hillslopes. Second, investigating and identifying the controlling variables (e.g. land use, land use vintage, aspect, elevation, etc.) related to the primary causes of sediment delivery is essential to developing effective rehabilitation and protection measures (Rosgen, 1996; Reid and Dunne, 1997).

Two or three drainage basins ranging in area from 300-1000 mi^2 in the Interior Columbia Basin will be selected for study of watershed and habitat responses to the storm/flood events of the past two years. In each selected study basin, at least two smaller watersheds that have had different levels of anthropogenic land disturbance will be selected for intensive investigation of watershed and habitat responses to the storm events; all watersheds selected for investigation will also have pre-storm data on substrate and pool conditions. To the extent possible, the smaller watersheds selected from within each study basin will be nested in a paired treatment (significantly logged and roaded) versus control (pristine or relatively unaltered) study design. Sampling within the selected watersheds will be structured to: (1) allow appropriately varied scales of analysis (2) include detailed inventory of the magnitude and frequency of mass failures and large-scale channel change in watersheds; (3) determine the frequency and magnitude of mass failure by land use condition; (4) investigate of the association of mass failures with types of land use; and (5) determine habitat response to the storms and its likely effects on salmon survival. Basins and sub-basins will be selected based on their exposure to the storm and flood events and their potential utility in regional extrapolation of results. Watersheds will be selected on the basis of their in-basin comparability with respect to natural attributes (vegetation, soils, elevation, size, etc.), proximity, differing levels of land use, and the availability of pre-storm data for habitat attributes.

Preliminary information indicates that the following subbasins may have watersheds that meet the selection criteria. The upper Clearwater River basin has pre-storm habitat data in several broadly comparable watersheds with greatly differing levels of land use (Huntington, 1995); the Middle Fork Salmon River has some of the same attributes as the upper Clearwater River basin; the South Fork of the Salmon River has been intensively studied with respect to fine sediment levels (Platts et al., 1989; Nelson et al., 1997) and also has watersheds with differing levels of land use. It would also be desirable to investigate potential sites in the Blue Mountains in order to provide data relevant to that "ecoregion."

Within each watershed selected for intensive investigation, index reaches of salmon habitat will be selected for resurvey of substrate conditions, pool attributes, and channel morphology, rather than surveying all salmonid habitat conditions, similar to the recommendation of Reid and Dunne (1997). Habitat index reaches within watersheds will be selected for study based on the availability of pre-storm habitat data, their use for spawning and rearing by salmon, and their relative sensitivity to changes in the habitat attributes under investigation, as recommended by Reid and Dunne (1997). Available information indicates that relatively low-gradient, unconstrained stream channels meet both criteria for selection for study (Rosgen, 1996). Pre-storm habitat surveys will be analyzed to establish baseline conditions in salmon habitat. Measurements of pool volume and frequency, and substrate condition will be performed as described in Huntington (1995). *A priori* estimates of the variability in habitat data will be made to provide an estimate of the number of measurements of habitat attributes needed to provide statistically significant results. Preliminary information indicates that the standard error of measured cobble embeddedness (%) in low-gradient streams in roadless and roaded watersheds in the Clearwater National Forest was, respectively, 5.14% (n=35) and 2.03% (n=180) while the mean difference in cobble embeddedness between these strata was 23% (Huntington, 1995). To evaluate changes in habitat conditions and their likely effect on egg-to-smolt salmon survival, current habitat conditions will be compared to pre-storm habitat conditions determined from pre-storm habitat surveys. Aerial photos and surveys may be used to augment the analysis of pre- and post-storm changes in habitat conditions.

Aerial overflights of the intensively studied watersheds will be used to inventory the number and locations of mass failures, zones of major channel change, and to identify areas for additional evaluation on the ground. The aerial inventory will also be used to determine the frequency of mass failures associated with specific types of anthropogenic land disturbance such as roads or clearcuts.

On-the-ground investigations in each watershed will be used, as necessary, to ground-truth and augment data from the aerial overflights. The magnitude of mass failures will be measured in each watershed to determine: a) the volume of mass failures at the watershed scale; b) the frequency and volume of mass failures associated with specific types of land use, such as undisturbed areas; and c) likely mechanisms of mass failure. Channel widening, sediment deposition, and other habitat conditions in each watershed will also be inventoried in the reaches of salmon habitat. A full sediment budget approach will not be undertaken because it is not required to meet project goals and deliverables. As noted by Reid and Dunne (1997) full sediment budgets (including erosion, transport, sedimentation, periodic re-mobilization, and export) are <u>not</u> necessary to evaluate every land management issue; the simplest possible approach should be employed (Reid and Dunne, 1997). In the case at hand, the study seeks to determine if: 1) habitat is improving or degrading; 2) there is a correlation between the direction of habitat change and land use; 3) there is an apparent relationship between the direction of habitat change and the volume and rate of mass failures; and 4) there is an apparent relationship among the volumetric rate of mass failures and potential controlling variables (e.g. slope, aspect,

land use, etc.) as recommended by Reid and Dunne (1997). These goals can be met with the proposed approach.

Precipitation and streamflow data from each study basin will be used to the estimate the magnitude of the major storm and flood events during the past two years within selected study basins. The recurrence interval for the precipitation events and peak streamflows will be estimated from historical records using standard hydrologic methods (Dunne and Leopold, 1978). This information will also be used to estimate the probability that precipitation and discharge events of equal or greater magnitude occur within these basins over the next 10 and 20 years.

f. Facilities and equipment.

No major special equipment is needed. Vehicles will be rented. The CRITFC has suitable office space and personal computers that support a variety of widely used word-processing, spreadsheet, and statistical analysis applications adequate to store and analyze data and report findings. Clearwater Biostudies, Inc. has suitable office space and personal computers that support a variety of widely used word-processing, spreadsheet, and statistical analysis applications adequate to store and analyze data and report findings. Clearwater Biostudies, Inc. also has GIS capabilities and equipment for digitizing aerial photos and maps.

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Section 8. Relationships to other projects

The proposed project will provide an updated assessment of the current condition of key aspects of salmonid habitat that can focus efforts to save weak salmon stocks from extirpation. The results will also aid in establishing regional and sub-regional watershed restoration priorities by providing an investigation of which land management activities resulted in the greatest damage to salmon habitat, similar to recommendations in Reid and Dunne (1997). In aggregate, the study will supply information to: determine trends in investigated habitats related to the objectives of NPPC (1994), CRITFC (1995) and USFS and USBLM (1994); target degraded habitat attributes in specific watersheds requiring recovery; and prioritize regional and sub-regional watershed restoration measures needed to improve egg-to-smolt survival for those badly depressed and declining anadromous and resident salmonid stocks in the upper Snake River Basin.

These project results will be presented to the Clearwater Subbasin Focus Watershed (Project # 9608600) and should aid the focus watershed in the development of prioritizing and implementing watershed and habitat restoration and protection measures.

Section 9. Key personnel

Charles W. Huntington, Senior Aquatic Biologist and Principal, Clearwater BioStudies, Inc., Project FTE: 0.22 with FY 98 project funds. Project Duties: Aid in study design, analysis of pre- and post-storm habitat data, coordination of field inventories of mass failures and habitat conditions, investigation of potential relationship of shifts in habitat condition to watershed response, analysis of GIS layers and aerial photos, synthesis of findings, contribution to final report. Education: B.S. Fisheries Science (Humboldt State Univ., 1978). Current Employer/Recent Previous Employment: Clearwater BioStudies, Inc. (1985-present) Current Responsibilities: Manage and participate in all aspects of projects related to evaluating aquatic conditions, assessing the environmental consequences of development activities and/or developing prescriptions for recovering degraded aquatic resources. Coordinate activities with government and non-governmental organizations, review technical reports, identify data needs, supervise field biologists/technicians, oversee QA/QC efforts, analyze data and write various reports. Expertise: Aquatic ecology, inventory of salmonid habitat conditions, salmonid biology, landscape to micro-scale analysis of salmonid habitat conditions, impact assessment/monitoring, technical writing, and biostatistics. Has monitored more than 750 streams which ranged in conditions and settings from remote wilderness streams to severely disturbed systems. Recent/relevant publications/job completions: 1) Aquatic Monitoring for Clearwater National Forest, Id. (1989-1997) Project Manager/Senior Biologist on more than 30 projects which evaluated aquatic habitat, riparian communities and fish populations along over 3000 km of salmonid streams. Field methods included analysis of over 100,000 habitat transects and fish population sampling (electrofishing and snorkeling) at approximately 2,500 representative stations. Personal responsibilities included: agency coordination, project management, training and field supervision of up to thirteen biologists and technicians, QA/QC activities, data collection and analysis, and report writing; 2) Huntington, C., W. Nehlsen and J. Bowers. 1996. A survey of healthy native stocks of anadromous salmonids in the Pacific Northwest and California. Fisheries 21(3):6-14; 3) Huntington, Charles W. 1995. Fish habitat and salmonid abundance within managed and unroaded landscapes on the Clearwater National Forest, Idaho. Final report to the Eastside Ecosystem Management Project, USDA Forest Service. Clearwater BioStudies, Inc.; 4) Huntington, Charles W. 1994. Stream and riparian conditions within the Grande Ronde Basin. Final report to the Grande Ronde Model Watershed Board. Clearwater BioStudies, Inc., Canby, Oregon.

Jon Rhodes, Hydrologist, Columbia River Inter-Tribal Fish Commission (CRITFC), Project FTE: 0.13 with FY 98 project funds. Project Duties: Project coordination and oversight, aid in study design, analysis of post-storm data on mass failures and potentially controlling variables, aerial inventory of mass failures as needed to fill data gaps, inventory of mass failures and potentially controlling variables, analysis of streamflow and precipitation data to determine recurrence intervals, analysis of potential relationship of mass failures to potentially controlling variables including land-use, synthesis of results, contributions to final report. Education: B.S. Hydrology and Water Resources (Univ. of Arizona, 1981); M.S. Hydrogeology (Univ. of Nev.-Reno, 1985); Ph.d. candidacy degree Forest Hydrology (Univ. of Wash., 1989). Certification status: None. Current Employer:

CRITFC (4/89-present). Current Responsibilities: Analysis of direct and cumulative effects of land-use on salmon habitat, channel morphology, water quality, and watershed processes. Provide scientific input as a member of numerous policy and technical forums dealing with aquatic issues, including forest practices and water quality monitoring programs. Recent Previous Employment: Research Assistant, Univ. of Wash. (11/88-4/89, 8/84-6/87); Consulting Hydrologist, Tahoe Regional Planning Assoc. (5-10/88, 7-10/87); Expertise: General watershed hydrology, water quality, direct and cumulative effects of land-use on aquatic resources, monitoring non-point source pollution, water temperature alteration, sedimentation, analysis of water quality data. Recent/relevant publications/job completions: 1) Co-author with eight others: 1992. The Upper Grande Ronde River Anadromous Fish Habitat Protection, Restoration and Monitoring Plan; 2) Rhodes, J.J., McCullough, D.A., and Espinosa, F.A., 1994. A Coarse Screening Process for Evaluation of the Effects of Land Management Activities on Salmon Spawning and Rearing Habitat in ESA Consultations. CRITFC Tech. Rept. 94-4, Portland, Or.--developed under contract with NMFS; 3) Espinosa, F.A., Rhodes, J.J., and McCullough, D. A. 1997. The failure of existing plans to protect salmon habitat on the Clearwater National Forest in Idaho. J. Env. Management **49**: 205-230; 4) Rhodes, J.J. and Purser, M.D., *in press*. Overwinter sedimentation of clean gravels in simulated redds in the upper Grande Ronde River and nearby streams in northeastern Oregon, USA: Implications for the survival of threatened spring chinook salmon, Proceedings of Forest-Fish Conference: Land Management Affecting Aquatic Ecosystems, Calgary, Alberta, Canada, May, 1995.

Dr. Chris Frissell, Research Assistant Professor, Flathead Lake Biological Station, The University of Montana, Project FTE: 0.03 with FY 98 project funds. Project Duties: Aid in study design and identification of data gaps in post-storm data sets, synthesis of findings in final report. Education: B.A. Zoology (Univ. of Montana, 1982); M.S. Fisheries Science (Ore. State Univ. (OSU), 1986): PhD. Fisheries Science (Ore. State Univ., 1992). Certification Status: . Current Employer: Flathead Lake Biological Station, The University of Montana (1993-present) and Dept of Fisheries and Wildlife, OSU (1994-present). Current Responsibilities: Research on: the cumulative impacts of human activities and natural processes on stream habitat and stream biota; ecology, biogeography, and conservation of fish in relation to landscape change; aquatic ecosystem conservation and restoration strategies. Recent Previous Employment: Postdoctoral Research Assoc. (Faculty), Dept. of Fisheries and Wildlife, OSU (1992-1994); Research Assistant (Faculty), Oak Creek Lab. of Biology, Dept. of Fisheries and Wildlife, OSU (1985-1992). Expertise: Cumulative effects of natural and anthropogenic disturbances on stream habitats and biota, hierarchical classification of watersheds and streams, multi-scale analysis of habitat conditions, conservation and restoration of fishes and aquatic biodiversity, He has conducted extensive field research on landscape change, stream habitat, and fish population response in coastal and Columbia Basin watersheds, and is directing regional studies to map areas most critical for aquatic conservation in the Pacific Northwest and northern Rocky Mountains. Recent/Relevant publications/job completions: 1) Frissell, C.A., Liss, W.J., Warren, C.E., and Hurley, M.D., 1986. A hierarchical framework for stream habitat classification: viewing streams in a watershed

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F. Al Espinosa, Jr., Consulting Fishery Biologist, Project FTE: 0.03 with FY 98 project funds. Project Duties: Aid in study design, aid in identification of data gaps in post-storm data sets on habitat conditions and watershed response, synthesis of findings in final report. Education: B.S. Fisheries (Humboldt State College, 1962); M.S. Aquatic Ecology and Ichthyology (Univ. of Nev.-Las Vegas, 1968). Certification Status: Certified Fisheries Scientist, Amer. Fish Society. Current Employer: Independent consultant (1993-present). Current Responsibilities: Analysis of project-level and cumulative effects on salmonids and salmonid habitats. Recent Previous Employment: Forest Fisheries Biologist, Clearwater National Forest, Id. (8/73-1/93) Expertise: Fish habitat monitoring methodology, fish habitat analysis, fish habitat protection measures, and the response of fish habitat to land-use activities in the Idaho batholith. Co-authored the "Guide for Predicting Salmonid Response To Sediment Yields in Idaho Batholith Watersheds" which remains one of the few quantitative tools for estimating the response of salmon and salmon habitat to changes in sediment yields caused by land-use. Considerable familiarity with existing habitat data and conditions in the Clearwater National Forest. Recent/relevant publications/job completions: 1) Co-author with 5 others, 1983. Guide for Predicting Salmonid Response to Sediment Yields in Idaho Batholith Watersheds. Northern Region, Missoula, Mont. and Intermountain Region, Boise, Id.; 2) Rhodes, J.J., McCullough, D.A., and Espinosa, F.A., 1994. A Coarse Screening Process for Evaluation of the Effects of Land Management Activities on Salmon Spawning and Rearing Habitat in ESA Consultations. CRITFC Tech. Rept. 94-4, Portland, Or.--developed under contract with NMFS; 3) McCullough, D.A. and Espinosa, F.A., 1996. A Monitoring Strategy for Application to Salmon Watersheds. CRITFC, Portland Or.--developed under contract with NMFS); 4) Espinosa, F.A., Rhodes, J.J., and McCullough, D. A. 1997. The failure of existing plans to protect salmon habitat on the Clearwater National Forest in Idaho. J. Env. Management **49**: 205-230.

Section 10. Information/technology transfer

Study results will be reported in annual and final reports, submitted for publication in a peer-reviewed journal, presented to watershed councils, including the Clearwater Subbasin Focus Subwatershed, and fish and land management entities, presented at symposia, and supplied to StreamNet.